Infrared Mapping of Volcanic Sulfur Dioxide Plumes: Examples From Mount Etna and Kilauea Volcanoes

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Realmuto et al. (1994) have demonstrated that image data acquired with NASA's airborne Thermal Infrared Multispectral Scanner (TIMS) can be used to estimate the S02 content of volcanic plumes. This estimation technique was developed using TIMS data acquired over Mount Etna, Sicily, on 29 July 1986. These data indicated that the S02 flux rate on that day was 6700 t/d (78 kg/s) .

The estimation procedure is based on the MODTRAN radiative transfer code (Berk et al., 1989), which is used to model the radiance perceived by TIMS as it views the ground through an intervening S02 plume. The estimation is an iterative inversion procedure, with ground temperature and S02 concentration as the model parameters. For the Mount Etna study, MODTRAN was run at each of the scores of iterations. This time-consuming mode of operation made the creation of a contiguous plume map too impractical.

The estimation procedure was modified to use a piecewise- linear approximation to describe the functional relationship between observed ground radiance and S02 concentration. This approximation requires that MODTRAN be run only 6 times for each point in the eventual plume map. Testing with synthetic data sets indicates that use of the approximation can result in overestimates of S02 of up to 10%. The errors appear to be independent of the S02 concentration.

The modified estimation procedure was used to create maps of the S02 plumes from the Puu Oo and Kupaianaha vents of Kilauea Volcano, Hawaii. The TIMS image data were acquired on 30 September 1988. The Puu Oo plume map depicts at least 3 S02- rich (15 - 30 g/m2) cells, or puffs, entrained in a SO2-poor (2 - 10 g/m2) stream. The TIMS image data compliments earlier descriptions of the puffing behavior of Puu Oo (ie. Chartier et al., 1988) by permitting the S02 contents of the different puffs to be mapped simultaneously.